WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: 2005PA40B

Title: Nitrate Source Tracking: Combining Isotopic, Microbial, and Chemical Tracers in a Mixed Land-Use Watershed

Project Type: Research

Focus Categories: Nitrate Contamination, Surface Water, Water Quality

Keywords: nitrates, bacteria, stable isotopes, hydrology, monitoring, Pennsylvania

Start Date: 03/01/2005

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Federal Funds: $18,000

Non-Federal Matching Funds: $36,000

Congressional District: 5th

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Abstract

Nitrate source tracking is a proposed new approach to identify point and non-point nitrate pollution sources by monitoring isotopic, microbial, and inorganic chemical tracers in stream water. Research has shown that 15N and 18O isotopes in nitrate offer opportunities for resolving organic vs. inorganic stream nitrate sources. Unfortunately, isotope applications have been limited in mixed land-use watersheds due to problems with source signature overlap for human and animal nitrate sources and with in-stream nitrogen transformations. Microbial source tracking using E. coli may help improve the success of nitrate source discrimination with isotopes, especially with regard to discriminating between human and animal nitrate sources. Inorganic chemicals such as sodium and chloride may help further discriminate among human sources of nitrate (e.g. sewage effluent).

The overall objective of this project is to develop, test, and improve current methods to trace sources of stream nitrate by using a combination of isotopic, microbial, and chemical indicators on Spring Creek, a mixed land-use watershed located in central Pennsylvania. Specific project objectives include:

1. Identify isotopic, chemical, and microbial characteristics of each major nitrate input (tributary inputs and major nitrate sources) to the Spring Creek watershed.

2. Develop relationships between 15N in nitrate and sources of E. coli bacteria to help distinguish between human and animal sources of nitrate.

3. Characterize variations of isotopic, chemical, and microbial tracers in time and space.
    a. Hydrological variation: baseflow and stormflow
    b. Seasonal variation: growing season versus dormant season
    c. Spatial variation: downstream changes in tracer signatures

4. Determine the most important sources of nitrate in the Spring Creek watershed.

To achieve the project objectives, a nested sampling design is proposed using five subwatersheds that represent a downstream progression of forested, agricultural, urban, and mixed land-uses (2 sites). Sewage treatment plant effluent also will be sampled, which discharges in between the two mixed land-use sites. Six storm events will be sampled during the one-year project period, three during the growing season and three during the dormant season. For each storm, a sample will be collected during antecedent baseflow conditions and at or near peakflow. Sewage treatment effluent will be sampled once during baseflow conditions and sequential precipitation samples will be collected during rain events. All samples will be analyzed for 15N and 18O in nitrate, E. coli bacteria (except in precipitation), and inorganic chemistry (NO3-, NH3, Cl-, Na+, SO42-, and PO43-).

We anticipate that this project will generate baseline data to show whether isotopes, E. coli bacteria, and inorganic chemical tracers can be used to identify nitrate sources in a mixed land-use watershed. Project results will also help characterize the seasonal and hydrological variation of tracer signatures and nitrate sources throughout the year. Finally, the results are expected to provide watershed managers and land-use planners with a new, cost-effective tool that helps identify and more efficiently manage point and non-point sources of nitrate pollution in mixed land-use watersheds.